CLAIMS

What is claimed is:

SHV 9/5/02

1. A method for embedding a sensor in a metal structure comprising:
   a) sputtering a first metallic layer on the sensor;
   b) electroplating a second metallic layer on the first metallic layer; and
   c) forming an embedding metallic layer on the second metallic layer, whereby the sensor is embedded in the metal structure.

2. The method of claim 1, wherein the sensor is a fiber optic sensor.

3. The method of claim 2 further comprising coating the sensor with an adhesive layer.

4. The method of claim 1, wherein the sensor is in the form of a thin film thermo-mechanical sensor.

5. The method of claim 4, wherein the sensor is formed by:
   i) depositing an adhesive layer on a substrate;
   ii) depositing a first insulating layer on the adhesive layer;
   iii) sputter-depositing and shaping a sensor layer on the first insulating layer; and
   iv) depositing a second insulating layer on the sensor layer.

6. The method of claim 5, wherein the first metallic layer is sputtered on the second insulating layer of the sensor.

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7. A metal embedded sensor comprising:
a metal structure comprising a metal having a melting temperature above 660°C; and
a sensor embedded inside the metal structure.

8. The metal embedded sensor of claim 7, wherein the metal structure comprises:
a coating metallic layer; and
an embedding metallic layer on the coating metallic layer.

9. The metal embedded sensor of claim 8, wherein the embedding metallic layer is formed by laser deposition.

10. The metal embedded sensor of claim 8, wherein the coating metallic layer comprises a first metallic layer, and a second metallic layer on the first metallic layer.

11. The metal embedded sensor of claim 10, wherein one or more of the first and the second metallic layers is formed by sputtering.

12. The metal embedded sensor of claim 10, wherein one or more of the first and the second metallic layers is formed by electroplating.

13. The metal embedded sensor of claim 10, wherein the first metallic layer is formed by sputtering, and the second metallic layer is formed by electroplating.

14. The metal embedded sensor of claim 10, wherein the thickness of the first metallic layer is between about one and about three microns.

15. The metal embedded sensor of claim 10, wherein the first metallic layer comprises a metal selected from the group consisting of copper, nickel, iron, and platinum.

16. The metal embedded sensor of claim 10, wherein the thickness of the second metallic layer is between about one-quarter and about two millimeters.

17. The metal embedded sensor of claim 10, wherein the second metallic layer comprises a metal selected from the group consisting of copper, nickel, iron, and platinum.

18. The metal embedded sensor of claim 17, wherein the sensor is in the form of a fiber optic sensor.

19. The metal embedded sensor of claim 18, further comprising an adhesive layer coating the sensor.

20. The metal embedded sensor of claim 19, wherein the adhesive layer comprises titanium.

21. The metal embedded sensor of claim 20, wherein the thickness of the adhesive layer is between about 2nm and about 3nm.

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22. The metal embedded sensor of claim 17, wherein the sensor is in the form of a thin film thermo-mechanical sensor.

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23. The metal embedded sensor of claim 22, wherein the sensor comprises:
a first insulating layer ;
a sensor layer disposed on the first insulating layer; and
a second insulating layer disposed on the sensor layer.

24. The metal embedded sensor of claim 23, wherein the sensor further comprises an adhesive layer contacting the first insulating layer.

25. The metal embedded sensor of claim 24, wherein the adhesive layer comprises titanium.

26. The metal embedded sensor of claim 25, wherein the thickness of the adhesive layer is between about 2nm and about 3nm.

27. The metal embedded sensor of claim 26, wherein the sensor further comprises a substrate contacting the adhesive layer.

28. The metal embedded sensor of claim 27, wherein the substrate comprises a metallic substrate.

29. The metal embedded sensor of claim 28, wherein the substrate comprises stainless steel.

30. The metal embedded sensor of claim 23, wherein the sensor layer comprises constantan.

31. The metal embedded sensor of claim 23, wherein the thickness of the first insulating layer is between about 10nm and about 15nm.

32. The metal embedded sensor of claim 23, wherein the thickness of the second insulating layer is between about 10nm and about 15nm.

33. The metal embedded sensor of claim 23, wherein the first and the second insulating layers comprise insulating oxides.

34. The metal embedded sensor of claim 33, wherein the first and the second insulating layers comprise alumina.

35. A remote non-contact sensing system to monitor the properties of structure having melting temperature above 660°C comprising:
a first metal embedded fiber optic sensor embedded in the structure;
a light source coupling to the first metal embedded fiber optic sensor; and
a photo-detector coupling to the first metal embedded fiber optic sensor.

36. The sensing system of claim 35, wherein the first metal embedded fiber optic sensor comprises:
a metal structure comprising a metal having a melting temperature above 660°c; and
a fiber optic sensor embedded inside the metal structure.

37. The sensing system of claim 36, wherein the metal structure comprises:
a coating metallic layer; and
an embedding metallic layer on the coating metallic layer.

38. The sensing system of claim 37, wherein the coating metallic layer comprises a first metallic layer, and a second metallic layer on the first metallic layer.

39. The sensing system of claim 38, wherein the first metallic layer is formed by sputtering.

40. The sensing system of claim 39, wherein the second metallic layer is formed by electroplating.

41. The sensing system of claim 40, wherein the embedding metallic layer is formed by laser deposition.

42. The sensing system of claim 40, wherein the embedding metallic layer is formed by casting.

43. The sensing system of claim 40, wherein the embedding metallic layer is formed by welding.

44. The sensing system of claim 35, wherein the light source comprises a wavelength tunable laser.

45. The sensing system of claim 44, wherein the tunable laser produces light having discrete wavelengths.

46. The sensing system of claim 35, wherein the light source comprises broad band laser diodes.

47. The sensing system of claim 46, wherein the broad band laser emits light with a broad spectra.

48. The sensing system of claim 35, wherein the light source couples to the sensor through a first optical fiber lead embedded inside the structure.

49. The sensing system of claim 48, wherein the first optical fiber lead comprises a first end connected to the first metal embedded fiber optic sensor and a second end adjacent to an external surface of the structure.

50. The sensing system of claim 49, further comprising a first aligning means for directing a light beam from the light source to the first end of the first optical fiber lead.

51. The sensing system of claim 50, wherein the first aligning means comprises an aligning lens.

52. The sensing system of claim 50, further comprising an isolator between the first aligning means and the light source to prevent the reflected light beam reflected from the first metal embedded fiber optic sensor.

53. The sensing system of claim 52, further comprising a first Erbium-doped fiber (EDF) between the light source and the isolator to amplify optical signals.

54. The sensing system of claim 35, wherein the photo-detector couples to the first metal embedded fiber optic sensor through a second optical fiber lead embedded inside the structure.

55. The sensing system of claim 54, wherein the second optical fiber lead comprises a first end connected to the first metal embedded fiber optic sensor and a second end adjacent to an external surface of the structure.

56. The sensing system of claim 55, further comprising a second aligning means for directing an output signal, modulated by a material property of the structure, from the first metal embedded fiber optic sensor to the photo-detector.

57. The sensing of claim 56, wherein the second aligning means comprises an aligning lens.

58. The sensing system of claim 57, further comprising a second EDF between the second aligning means and the photo-detector to amplify the optical signals.

59. The sensing system of claim 35, further comprising a data acquisition system connected to the photo-detector and the light source.

60. The sensing system of claim 35, further comprising a second metal embedded fiber optic sensor embedded in a different location in the structure.

61. The sensing system of claim 35, wherein embedded fiber optic sensor comprises one or more sensors.

62. The sensing system of claim 35, wherein the structure is a rotating structure having a rotational axis.

63. The sensing system of claim 62, wherein the first and second optical fiber leads are positioned substantially parallel with the rotational axis of the rotating structure.